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A SIMPLE, INEXPENSIVE AND RELIABLE METHOD OF MEASURING OF NITROGEN DIOXIDE CONCENTRATION IN AMBIENT AIR

The simple and inexpensive samplers based on the collection of gaseous pollutants of ambient air in the filter paper impregnated with an absorption solution have been developed and described in details. Methods enabling determinations of absolute pollutant concentrations in the air based on the sampler results have been also presented.

In order to survey areal air pollution the concentration of the air pollutant should be measured simultaneously at a sufficient number of point in this area. For an air pollutant whose emission sources are enclosed within a small area, a general aspect of the pollution may be described by the data from a relatively small number of measuring points. But for a pollutant, such as NO_x whose emission sources are spread over a wide area, a large number of measuring points are necessary to get a detailed pollution map of this area. Usually the apparatus for measuring air pollution is, however, very expensive and the number of measuring points is limited due to financial restrictions.

In order to overcome those difficulties we have developed a simple and inexpensive but reliable method of measuring NO_2 in ambient air. The essence of the method is a simple sampler utilizing a piece of filter paper impregnated with alkali solution.

The most popular sampler which has been widely used in Japan since 1973 is shown in fig. 1. The sampler consists of a small plastic vessel covered a lid. A piece of filter paper impregnated with an aqueous solution of triethanol amine is tightly fitted to the inside wall of the vessel. If NO_2 pollution is to be measured, the lid of the sampler may be put off, the sampler turned down and set at the place desired, thus exposing the filter paper to ambient air for a definite time. Thereupon the lid is put on the sampler taken for analysis. To determine the quantity of NO_2 collected in the filter paper, the lid is put off again

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and 5 ml of Saltzman solution poured into the sampler vessel for colour development, left for about 15 minutes and absorbance of the solution is measured at 540 nm. The result is proportional to the product of the average concentration of NO_2 in ambient air and the exposure time.

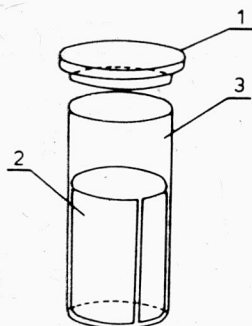


Fig. 1. Mini-sampler

1 — lid, 2 — filter paper (2 cm × 4.4 cm), 3 — plastic vessel

Rys. 1. Mini-próbnik

1 — pokrywa, 2 — bibuła filtracyjna (2 cm × 4,4 cm), 3 — naczynie plastikowe

The Saltzman solution is prepared by dissolving 5 g of sulfanilic acid and 50 mg of N-1-naphthyl-ethylenediamine hydrochloride in several hundred ml of water, adding 30 ml of 80% phosphoric acid and making up the solution to 1 dm³ with water. This solution, if properly kept in the dark, is stable for several months.

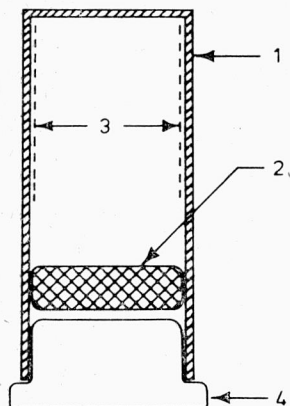


Fig. 2. Mini-sampler with sponge

1 — plastic vessel, 2 — sponge put off by the pincett at analysis, 3 — filter paper, 4 — lid (put off at exposure time)

Rys. 2. Mini-próbnik z gąbką

1 — naczynie plastikowe, 2 — gąbka wyjęta pincetą do analizy, 3 — bibuła filtracyjna, 4 — pokrywa (zdjęta na czas ekspozycji)

A powdered mixture of 5 g of sulfanilic acid, 30 g of tartaric acid and 50 mg of N-1-naphthyl-ethylenediamine hydrochloride is very convenient for transportation. Saltzman solution can be easily prepared by dissolving this mixture in 1 dm³ of pure water on the spot.

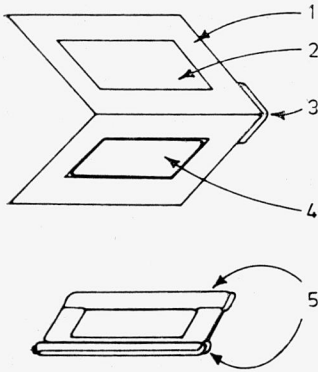


Fig. 3. High-efficiency mini-sampler

1 – slide frame, 2 – porous polypropylene film, 3 – adhesive tape,
4 – filter paper impregnated with alkali solution, 5 – rubber ring

Rys. 3. Wysoko wydajny mini-próbnik

1 – ramka do przezrocy, 2 – porowata warstwa polipropylenowa, 3 – taśma klejąca, 4 – bibuła filtracyjna nasączona roztworem zasadowym,
5 – pierścień gumowy

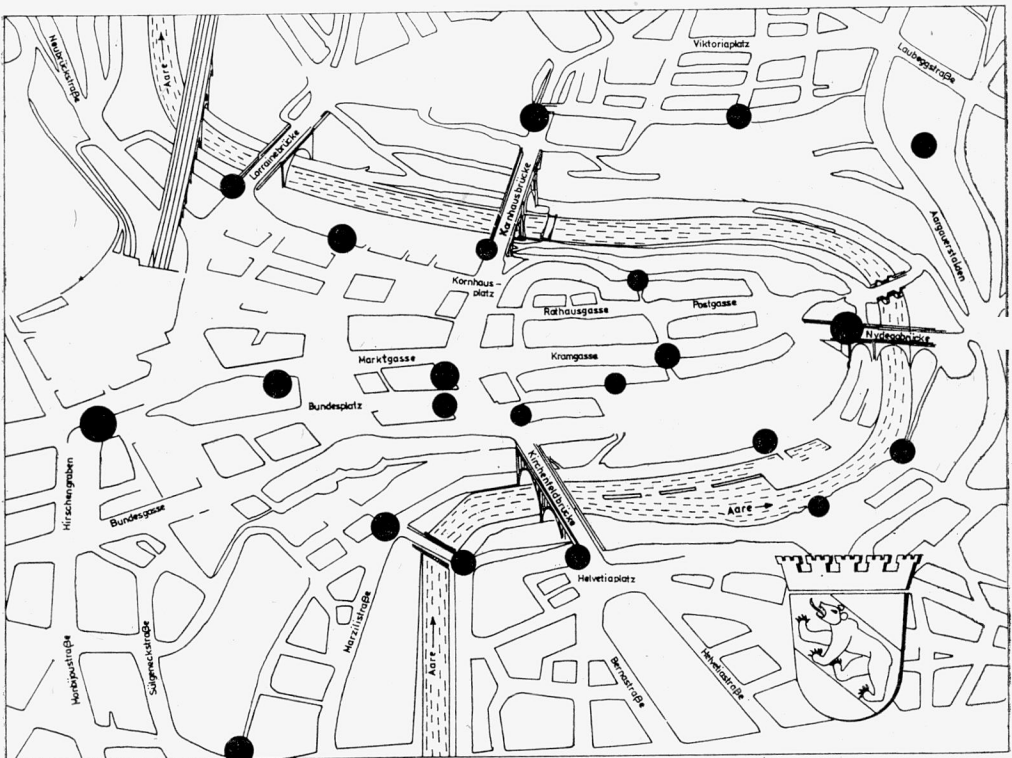


Fig. 4. Nitrogen dioxide concentration in Bern on March 31, 1980

The diameters of circles are proportional to nitrogen dioxide concentration

Rys. 4. Stężenie dwutlenku azotu w Bernie 31 marca 1980

Średnice kółek proporcjonalne do stężenia dwutlenku azotu

The sampler vessel has the following three functions being an air-tight storage container before and after the exposure to ambient air, a shelter during the period of exposure to ambient air, a shelter during the period of exposure and a test tube for colour development. This contributes greatly to labour saving in treating a large number of samples.

The collection coefficient of the sampler, that is the ratio of quantity of NO_2^- collected during one day exposure and the daily average concentration of NO_2 in ambient air, almost lie within 30% of average value, except for the day on which strong wind blows.

In order to reduce or eliminate the influence of wind, porous film or sponge may be put at the opening of the vessel, as shown in fig. 2. This sampler is well suited for a simultaneous measurement of air pollution at a very large number of points to get the relative value of pollution of the area.

Absolute value of NO_2 concentration may be obtained by comparing the NO_2 concentration measured by a standard apparatus with that obtained by the sampler at a few points.

In order to get reliable hourly average value, a sampler with high collection without wind effect has been developed recently. This is shown in fig. 3.

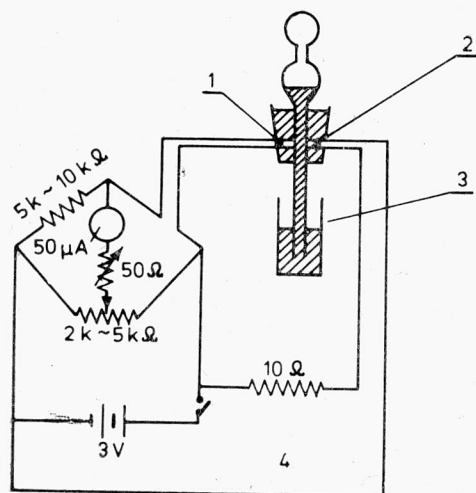


Fig. 5. Amayas' colorimeter

1 — cadmium sulfide photoconductive detector, 2 — green high emitting diode, 3 — plastic vessel, 4 — switch

Rys. 5. Kolorymetr Amayasa

1 — fotoprzewodzący detektor z siarczku kadmu, 2 — dioda emitująca zielone światło, 3 — naczynia plastikowe, 4 — przełącznik

The sampler consists of two frames for photographic film holder with porous hydrophobic film through which the pollutant molecules can penetrate. The frames are fixed with an adhesive tape at one edge to form a hinge. 2 cm × 3 cm piece of filter paper is put between the two frames and kept closed by a clip or a rubber ring.

These samplers were successfully used by one of the authors (SUGIURA) to measure 4 hour average (0.043 ppm) concentration of NO_2 in Bern, Switzerland on March 31,

1980 on an occasion of 2nd European Conference on Environmental Education. Collection coefficient of these samples depends on such parameters as quality and size of filter paper, concentration of triethanolamine and quantity of the solution added per one piece of filter paper. If the parameters are the same for all the samplers, then reproducible data can be obtained.

For example, when 2 cm × 3 cm filter paper of Toyo Roshi No. 50 impregnated with 0.12 ml of aqueous solution of 20% (V/V) triethanolamine is used in the slide frame sampler (fig. 3), the collection coefficient is 50 μg NO₂ per 0.1 ppm and per day with 2% dispersion.

A suction type colorimeter employing Light Emitting Diode and CdS photoconductive detector as shown in fig. 5 is designed. Colour density is measured only by sucking coloured solution. This colorimeter is quite convenient in measuring a large number of samples.

These samplers can be applied to other pollutants, such as SO₂, O₃, HCl, NH₃, and HCN by using proper collecting reagents.

PROSTA, TANIA I PEWNA METODA POMIARU STĘŻENIA DWUTLENKU AZOTU W POWIETRZU ATMOSFERYCZNYM

Podano dokładny opis prostych i tanich urządzeń do poboru prób i oznaczania gazowych zanieczyszczeń powietrza atmosferycznego przy użyciu bibuły filtracyjnej nasyconej roztworem absorbującym. Urządzenia te są przystosowane do pomiarów w cyklach dobowych i godzinowych. Podano także sposoby obliczania rzeczywistych stężeń zanieczyszczeń powietrza na podstawie wyników otrzymanych z tych urządzeń.

EINE EINFACHE, PREISWERTE UND SICHERE MESSMETHODE DES NO₂ IN DER LUFT

Beschrieben werden einfache und preiswerte Geräte zur Probenahme und zur Bestimmung von gasförmigen Verunreinigungen der Luft. Das Gerät ist mit einem Filtrierpapier ausgestattet welches mit einem Absorptionsmittel gesättigt ist. Die Geräte werden für das Messen für Tages- und Stundenintervalle eingestellt. Angeführt sind entsprechende Umrechnungsmethoden von Meßergebnissen, die in wirklichen Konzentrationen der Luftverunreinigungen resultieren.

ПРОСТОЙ, ДЕШЁВЫЙ И НАДЁЖНЫЙ МЕТОД ИЗМЕРЕНИЯ КОНЦЕНТРАЦИИ ДВУОКСИ АЗОТА В АТМОСФЕРНОМ ВОЗДУХЕ

Приведено подробное описание простых и дешёвых установок для отбора проб и определения загрязнений атмосферного воздуха при использовании фильтровальной бумаги, насыщенной поглотительным раствором. Эти установки приспособлены для измерений в суточных и часовых циклах. Приведены также способы расчётов реальных концентраций загрязнений воздуха на основе полученных результатов из этих установок.